ON SOME FORAMINIFERA FROM THE NORTHEASTERN PART OF THE ARABIAN SEA

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ABSTRACT

Sediment core samples collected from the northeastern part of the Arabian Sea during cruise-2 on board I.N.S. ‘Darshak’ in January to February, 1967 have been analysed for study of the nature and distribution of Foraminifera. Ninety-two species of Foraminifera belonging to 40 genera of 16 families, viz., Textulariidae, Valvulinidae, Miliolidae, Ophthalmidiidae, Trochamminidae, Lagenidae, Planorbulinidae, Nonionidae, Camerinidae, Heterohelicidae, Buliminidae, Rotaliidae, Calcariidae, Globigerinidae, Globorotaliidae and Anomalinidae have been identified and reported. Composition of Foraminifera and their concentration at different stations have been studied with reference to depth and state of preservation, benthic and planktonic Foraminifera being dealt with separately.

Foraminiferal species recorded for the first time in Indian waters are (1) Textularia pseudocarinata Cushman, (2) Virgulina concava Höglund, (3) Virgulina pauciloculata H. B. Brady, (4) Loxostoma rostrum Cushman, (5) Lagena sulcata (Walker and Jacob) var. spicata Cushman and McCulloch, (6) Lagena costata (Williamson) var. amphora Reuss, (7) Elphidium oceanicum Cushman, (8) Discorbis auracana Cushman and (9) Globigerina calida Parker.

The foraminiferal fauna of the continental shelf waters of the northwestern part of India is similar to that of Gulf of Cambay and most of the species reported in this paper are also known from the tropical Pacific and Philippines.

INTRODUCTION

As evident from literature on Foraminifera, our knowledge on the distribution of this group in shallow coastal waters of India is very meagre although work done on systematics is somewhat satisfactory. The most outstanding contribution to the study of Foraminifera in the deeper regions of Arabian

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Sea is that of Stubbings of John Murray Expedition, 1933-34. This expedition also has given some information on Foraminifera present in shallow waters of south Arabian Sea and Maldive area. An account of Foraminifera from the Laccadive region has been given by Chapman (1895). Chaudhury and Biswas (1954) reported certain perforate Foraminifera from the Juhu beach, Bombay. Bhatia (1956) recorded some Foraminifera from shore sands of the beaches-Juhu and Chowpatty (Bombay) and Bhogat (Saurashtra). Sethulekshmi Amma (1958) studied Foraminifera from the inshore waters of the Trancore coast and Chatterjee and Gururaja (1967) from the Arabian Sea off Mangalore coast. There is no reference available at present on Foraminifera below 100 fathoms in the coastal waters off the northwestern part of India except the account given by Rao (1970) for the Gulf of Cambay.

The study of core samples is restricted to top one centimeter of the core so as to have a broad picture of the foraminiferal fauna and their horizontal distribution in the investigated area.

**METHOD OF STUDY**

The sediment cores from the bottom of the continental shelf waters of the northeastern part of the Arabian Sea were obtained by a gravity corer. A total number of eight core samples was collected. For the foraminiferal study the top one centimeter of the core was separated and part of the material from this portion of the sample was then washed through 200 mesh screen. The sieved material was then examined using a Stereo Binocular Microscope. The methods for counting and percentage calculations of different groups of Foraminifera are those of Phleger (1965). Sketches were drawn using a camera lucida of prism type.

**TAXONOMY OF FORAMINIFERA FROM THE NORTHEASTERN PART OF THE ARABIAN SEA**

Family TEXTULARIIDAE

Subfamily TEXTULARIINAE

Genus *Textularia* Defrance, 1824

- *(1)* *Textularia cuneiformis* d'Orbigny, Fig. 8
- *(2)* *Textularia agglutinans* d'Orbigny, Fig. 9
- *(3)* *Textularia conica* d'Orbigny, Fig. 10
- *(4)* *Textularia candeiana* d'Orbigny
- *(5)* *Textularia pseudocarinata* Cushman, Fig. 11
Family VALVULINIDAE
Subfamily EGGERELLINAE
Genus Eggerella Cushman, 1933

(6) Eggerella bradyi (Cushman)

Family MILIOLIDAE
Genus Spiroloculina d’Orbigny, 1826

(7) Spiroloculina depressa d’Orbigny
(8) Spiroloculina depressa var. rotundata Williamson.
(9) Spiroloculina grateloupi d’Orbigny

Genus Quinqueloculina d’Orbigny, 1826

(10) Quinqueloculina seminulum (Linnaeus)
(11) Quinqueloculina vulgaris d’Orbigny
(12) Quinqueloculina lamarckiana d’Orbigny
(13) Quinqueloculina venusta Karrer, Fig. 12
(14) Quinqueloculina ferussacii d’Orbigny, Fig. 13

Genus Triloculina d’Orbigny, 1826

(15) Triloculina trigonula (Lamarck)
(16) Triloculina tricarinata d’Orbigny
(17) Triloculina circularis Bornemann
(18) Triloculina cuneata Karrer, ‘Biloculine variety’, Fig. 14
(19) Triloculina oblonga (Montagu)
(20) Triloculina terquemiana (H. B. Brady), Fig. 15
(21) Triloculina linnaeana d’Orbigny, Fig. 16
(22) Triloculina echinata d’Orbigny

Genus Ammomassilina, Cushman, 1933

(23) Ammomassilina alveoliniformis (Millett), Fig. 17

Genus Hauerina d’Orbigny, 1839

(24) Hauerina fragilissima (H. B. Brady)

Genus Tubinella Rhumbler, 1906

(25) Tubinella funalis var. inornata (H. B. Brady), Fig. 18

Genus Pyrgo Defrance, 1824

(26) Pyrgo subspherica d’Orbigny, Fig. 19
Family OPHTHALMIIDAE
Subfamily CORNUSPIRINAE
Genus Cornuspira Schultze, 1854
(27) Cornuspira involvens (Reuss), Fig. 21
Genus Cornuspiroides Cushman, 1928
(28) Cornuspiroides foliaceus (Philippi), Fig. 20
Family TROCHAMMINIDAE
Subfamily TROCHAMMINAE
Genus Trochammina Parker and Jones, 1859
(29) Trochammina inflata (Montagu)

Family LAGENIDAE
Subfamily NODOSARIINAE
Genus Nodosaria Lamarck, 1812
(30) Nodosaria radicula (Montagu)
Subfamily LAGENINAE
Genus Lagena Walker and Jacob, 1798
(31) Lagena globosa (Montagu)
(32) Lagena laevis (Montagu), Fig. 22
(33) Lagena gracillima (Seguenza), Fig. 23
(34) Lagena punctulata Sidebottom Fig. 24
(35) Lagena perlicuda (Montagu), Fig. 25
(36) Lagena hexagona (Williamson), Fig. 26
(37) Lagena striata (d’Orbigny)
(38) Lagena semistriata Williamson, Fig. 27
(39) Legena sulcata (Walker and Jacob) var. spicata Cushman and McCulloch, Fig. 28
(40) Lagena costata (Williamson), var. amphora Reuss, Fig. 29
(41) Lagena quadrata (Williamson)
(42) Lagena marginata (Walker and Boys)
(43) Lagena marginato-perforata Seguenza, Fig. 30
(44) Lagena lagenoides (Williamson), Fig. 31
(45) Lagena orbignyana (Seguenza)
Some Foraminifera from Northeastern Part of the Arabian Sea

Genus *Robulus* Montfort, 1808

(46) *Robulus limbosus* (Reuss), Fig. 32

Family PLANORBULINIDAE

Genus *Planorbulinella* Cushman, 1927

(47) *Planorbulinella larvata* (Parker and Jones), Fig. 33

Family NONIONIDAE

Genus *Nonion* Montfort, 1808

(48) *Nonion boueanum* (d'Orbigny)

(49) *Nonion scapha* (Fichtel and Moll), Fig. 34

Genus *Elphidium* Montfort, 1808

(50) *Elphidium advena* (Cushman), Fig. 35

(51) *Elphidium striato-punctatum* (Fichtel and Moll) Cushman and Leavitt, Fig. 36

(52) *Elphidium oceanicum* Cushman, Fig. 37

(53) *Elphidium simplex* Cushman, Fig. 38

(54) *Elphidium excavatum* (Terquem), Fig. 39

Family CAMERINIDAE

Subfamily CAMERININAE

Genus *Operculina*, d'Orbigny, 1826

(55) *Operculina gaimairdi*, d'Orbigny

Family HETEROHELICIDAE

Subfamily BOLIVINITINAE

Genus *Bolivinella* Cushman, 1927

(56) *Bolivinella margaritacea* Cushman, Fig. 40

Family BULIMINIDAE

Subfamily BULIMININAE

Genus *Bulimina* d'Orbigny, 1826

(57) *Bulimina marginata* d'Orbigny
Subfamily Virgulininae

Genus Virgulina d’Orbigny, 1826

(58) Virgulina squamosa d’Orbigny
(59) Virgulina concava Höglund, Fig. 41
(60) Virgulina pauciloculata H. B. Brady, Fig. 42

Genus Bolivina d’Orbigny, 1839

(61) Bolivina nobilis Hantken
(62) Bolivina vadescens Cushman
(63) Bolivina hantkeniana H. B. Brady, Fig. 43
(64) Bolivina capitata Cushman, Fig. 44
(65) Bolivina striatula Cushman, Fig. 45

Genus Loxostoma Ehrenberg, 1854

(66) Loxostoma limbatum (H. B. Brady)
(67) Loxostoma rostrum Cushman, Fig. 46

Subfamily Uvigerininae

Genus Uvigerina d’Orbigny, 1826

(68) Uvigerina ampullacea H. B. Brady, Fig. 47
(69) Uvigerina proboscidea Schwager, Fig. 48

Family Rotaliidae

Subfamily Discorbinae

Genus Discorbis Lamarck, 1804

(70) Discorbis globularis (d’Orbigny)
(71) Discorbis roacea (d’Orbigny)
(72) Discorbis vilardeboana (d’Orbigny)
(73) Discorbis auracana (d’Orbigny), Fig. 49
(74) Discorbis bertheloti (d’Orbigny)

Genus Lamarckina Berthelin, 1881

(75) Lamarckina ventricosa (H. B. Brady), Fig. 50

Subfamily Rotaliinae

Genus Eponides Montfort, 1808

(76) Eponides repandus (Fichtel and Moll), Fig. 51
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Genus *Streblus* Fischer, 1817

*(77)* *Streblus beccarii* (Linnaeus) var. *koebeelen*s (Le Roy)

Subfamily BAGGININAE

Genus *Cancris* Montfort, 1808

*(78)* *Cancris auricula* (Fichtel and Moll), Fig. 52

Family CALCARINIDAE

Genus *Calcarina* d'Orbigny, 1826

*(79)* *Calcarina calcar* d'Orbigny

Family GLOBIGERINIDAE

Genus *Globigerina* d'Orbigny, 1826

*(80)* *Globigerina bulloides* d'Orbigny

*(81)* *Globigerina calida* Parker, Fig. 53

Genus *Globigerinella* Cushman, 1927

*(82)* *Globigerinella aequilateralis* (H. B. Brady)

Genus *Globigerinoides* Cushman, 1927

*(83)* *Globigerinoides ruber* (d'Orbigny), Fig. 54

*(84)* *Globigerinoides sacculifer* (H. B. Brady), Fig. 55

Genus *Orbulina* d'Orbigny, 1839

*(85)* *Orbulina universa* d'Orbigny, Fig. 56

Family GLOBOROTALIIDAE

Genus *Goboquadrina* Finlay, 1947

*(86)* *Goboquadrina dutertrei* (d'Orbigny)

Genus *Goborotalia* Cushman, 1927

*(87)* *Goborotalia menardii* (d'Orbigny)

*(88)* *Goborotalia tumida* (H. B. Brady), Fig. 57

Family ANOMALINIDAE

Subfamily ANOMALININAE

Genus *Planulina* d'Orbigny, 1826

*(89)* *Planulina ornata* (d'Orbigny), Fig. 58

Genus *Anomalinella* Cushman, 1927

*(90)* *Anomalinella rostrata* (H. B. Brady), Fig. 59
Subfamily Cibicidinae
Genus Cibicides Montfort, 1808

(91) Cibicides lobatulus (Walker and Jacob)
(92) Cibicides pseudoungeriana (Cushman)

Description of the area and location of stations

The study area extends between Longitudes 72° 2' E and 68° 16' E and Latitudes 19° 7' N and 23° 22' N. The stations covered in the northeastern part of the Arabian Sea from where samples have been collected are given in Table I (Fig. 1).

Fig. 1. Map of Northeastern part of the Arabian Sea showing location of stations.
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ECOLOGICAL DATA

Depth and surface water temperature measurements have been made at all the stations covered. The water depths at the stations have been found to vary between 11 and 77 meters (Fig. 2) and the water temperature from 20°C to 24.7°C (Fig. 3). Description of the nature of the substrata at the sampling stations is given in Table I.

TABLE I

Location of stations

<table>
<thead>
<tr>
<th>Station No.</th>
<th>Location (North)</th>
<th>Location (East)</th>
<th>Depth (m.)</th>
<th>Temperature °C (Surface)</th>
<th>Sediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>19° 7' N.</td>
<td>72° 2' E.</td>
<td>64</td>
<td>24.71</td>
<td>Sandy</td>
</tr>
<tr>
<td>22</td>
<td>19° 47.5' N.</td>
<td>71° 09.0' E.</td>
<td>64</td>
<td>23.89</td>
<td>Sandy</td>
</tr>
<tr>
<td>23</td>
<td>20° 16.7' N.</td>
<td>70° 34.5' E.</td>
<td>77</td>
<td>23.89</td>
<td>Muddy sand</td>
</tr>
<tr>
<td>24</td>
<td>21° 43.6' N.</td>
<td>69° 14.6' E.</td>
<td>37</td>
<td>21.71</td>
<td>Sandy mud</td>
</tr>
<tr>
<td>25</td>
<td>22° 31.0' N.</td>
<td>68° 30.0' E.</td>
<td>27</td>
<td>21.95</td>
<td>Muddy</td>
</tr>
<tr>
<td>26</td>
<td>23° 18.0' N.</td>
<td>68° 16.0' E.</td>
<td>14</td>
<td>21.10</td>
<td>Muddy</td>
</tr>
<tr>
<td>27</td>
<td>23° 22.0' N.</td>
<td>68° 18.0' E.</td>
<td>11</td>
<td>21.95</td>
<td>Muddy</td>
</tr>
<tr>
<td>28</td>
<td>23° 08.0' N.</td>
<td>68° 23.0' E.</td>
<td>16</td>
<td>20.00</td>
<td>Muddy</td>
</tr>
</tbody>
</table>

DISTRIBUTION OF FORAMINIFERA

Composition of Foraminifera at the stations covered in the area of study is as follows:

Station 21: Foraminiferal content is very rich. Miliolids are dominant followed by Rotaliidae, Buliminidae, Nonionidae, Textulariidae, Anomalinidae, Ophthalmidiidae, Valvulinidae and Planorbulinidae in the order of abundance. Lagenids are common in the sample. Rotalids are represented by genera such as Discorbis, Lamarckina, Eponides, Streblus and Cancris. Among the miliolids the most common genera are Spiroloculina, Quinqueloculina and Triloculina. Planorbulinella larvata is rare.

Planktonic Foraminifera like Globigerina bulloides, Globigerinoides ruber and Globorotalina dumerrei are common and Globorotalia tumida is very rare. These pelagic specimens make up to 23.33%.
Figs. 2-7. Ecological factors and distribution analyses of foraminiferal fauna.
Station 22: The fauna at this station is as rich as at the previous station so far as the number of specimens is concerned but represented by relatively lesser number of families. Textulariidae, Miliolidae, Lagenidae, Nonio.
nidae, Buliminidae and Rotaliidae are found at this station. The dominant species of Foraminifera are *Streblus beccarii* (Linnaeus) var. *koëboeensis*, *Bulimina marginata*, *Bolivina nobilis*, *Uvigerina ampullacea*, *Lagena striata* and *Lagena globosa*. Miliolids are less frequent.

Many planktonic Foraminifera, i.e., *Globigerina bulloides*, *Globigerinoides ruber*, *Orbulina universa*, *Globoquadrina dutertrei* and *Globorotalia menardii* have been found forming up 24·66% of the total fauna.

Station 23: The fauna is comparatively very rich and the greatest abundance of specimens of Foraminifera is found at this station. Miliolidae, Rotaliidae, Buliminidae, Nonionidae, Lagenidae, Anomaliniidae and Valvulinidae have been reported from this station. Some of the dominant genera at this station are *Spiroloculina*, *Quinqueloculina*, *Streblus*, *Discorbis*, *Bulimina* and *Nonion*. *Virgulina pauciloculata*, *V. concava*, *V. squamosa* and *Uvigerina proboscidea* are rare. Lagenids are common.

The most dominant species of planktonic Foraminifera are *Globigerinella aequilateralis* and *Globigerinoides ruber*. *Globoquadrina dutertrei* is present. *Globigerina calida* and *Globigerinoides sacculifer* are very rare species. Planktonic Foraminifera are most abundant constituting 30·66% of the total fauna.

Station 24: The fauna at this station is relatively poor compared to the previous stations. Families of Foraminifera represented at this station are Rotaliidae, Buliminidae, Nonionidae, Lagenidae, Miliolidae, Ophthalmo-midiidae and Trochamminidae in the order of abundance. *Discorbis rosacea*, *D. vilardeboana*, *Bolivina nobilis*, *B. striatula* and *Bulimina marginata* are common. *Trochammina inflata* is a very rare specimen at this station. *Elphidium advena* is very dominant. Miliolids are very sparse.

A few specimens of *Globigerina bulloides* are observed at this station.

Station 25: Foraminiferal families represented at this station are Rotaliidae, Miliolidae, Nonionidae, Buliminidae, Camerinidae and Lagenidae. Some very dominant rotalids are *Streblus beccarii* (Linnaeus) var. *koëboeensis* and *Discorbis rosacea*. Miliolids and lagenids are sparsely present. *Operculina gaimairdi* is rare. *Elphidium simplex* and *El. advena* are very abundant. *Bolivina*, *Bulimina* and *Virgulina* are dominant genera of the family Buliminidae. *Nonion boueancum*, *Bolivina striatula*, *Bulimina marginata* and *Virgulina squamosa* are common.
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Planktonic Foraminifera make up 5.33% of the total fauna and are represented by the lone species of *Globigerina bulloides*.

Station 26: The foraminiferal fauna at this station is very poor compared to the previous stations. Some families of this group reported from this station are Miliolidae, Rotaliidae, Buliminidae and Camerinidae. Miliolids of the genera *Triloculina* and *Quinqueloculina* are rare. Rotalids belonging to the genera *Streblus* and *Discorbis* have been observed. *Bolivina* and *Bulimina* are sparsely present.

Only a few specimens of *Globigerina bulloides* have been observed.

Station 27: As compared with the previous station the fauna is still poorer. Some families of Foraminifera that have been reported are Miliolidae, Rotaliidae, Buliminidae, Lagenidae, Anomaliniidae and Heterohelicidae. The dominant family at this station is Miliolidae and dominant genera of this family are *Quinqueloculina* and *Triloculina*. *Quinqueloculina vulgaris*, *Q. seminulum*, *Triloculina circularis*, *Tr. oblonga* and *Tr. tricornata* are common. The family Rotaliidae is represented by the same genera as reported at the previous station. *Bolivinella margaritacea*, a rare species is present.

**Table II**

*Frequency of occurrence of foraminiferal species at different stations*

<table>
<thead>
<tr>
<th>Station Number</th>
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<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
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<td>Depth in Meters</td>
<td>64</td>
<td>64</td>
<td>77</td>
<td>37</td>
<td>27</td>
<td>14</td>
<td>11</td>
<td>16</td>
</tr>
</tbody>
</table>

Benthic Species

(1) *Textularia cuneiformis*  
(2) *Textularia agglutinans*  
(3) *Textularia conica*  
(4) *Textularia candeliana*  
(5) *Textularia pseudocarinata*  
(6) *Eggerella bradyi*  
(7) *Spiroloculina depressa*  
(8) *Spiroloculina depressa* var. *rotundata*
**Table II (Contd.)**

<table>
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<tr>
<th>Station Number</th>
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<th>22</th>
<th>23</th>
<th>24</th>
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<td>37</td>
<td>27</td>
<td>14</td>
<td>11</td>
<td>16</td>
</tr>
</tbody>
</table>

Benthic Species

1. *Spiroloculina grateloupi*  
2. *Quinqueloculina seminulum*  
3. *Quinqueloculina vulgaris*  
4. *Quinqueloculina lamarckiana*  
5. *Quinqueloculina venusta*  
6. *Quinqueloculina ferussacii*  
7. *Triloculina trigonula*  
8. *Triloculina tricarinata*  
9. *Triloculina circularis*  
10. *Triloculina cuneata*  
11. *Triloculina oblonga*  
12. *Triloculina terquemiana*  
13. *Triloculina linnaeana*  
14. *Triloculina echinata*  
15. *Ammomassilina alveoliformis*  
16. *Hauerina fragilissima*  
17. *Tubinella funalis var. inornata*  
18. *Pyrgo subspherica*  
19. *Cornuspira involvens*  
20. *Cornuspiroides foliaceus*  
21. *Trochammina inflata*  
22. *Nodosaria radicula*  
23. *Lagena globosa*  
24. *Lagena laevis*
TABLE II (Contd.)

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<td>16</td>
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</table>

**Benthic Species**

(33) *Lagena gracillima* * *

(34) *Lagena punctulata* *

(35) *Lagena perlicida* *

(36) *Lagena hexagona* *

(37) *Lagena striata* ** *** ** * * *

(38) *Lagena semistriata* *

(39) *Lagena sulcata* (Walker and Jacob) var. *spicata*

(40) *Lagena costata*
    (Williamson) var. *amphora*
    *

(41) *Lagena quadrata* *

(42) *Lagena marginata* ** * * *

(43) *Lagena marginatoperforata* *

(44) *Lagena lagenoides* *

(45) *Lagena orbignyana* *

(46) *Robulus limbosus* *

(47) *Planorbulinella larvata* *

(48) *Nonion boueanum* ** ** * * ** *

(49) *Nonion scapha* *

(50) *Elphidium advena* *

(51) *Elphidium striato-punctatum* *

(52) *Elphidium oceanicum* *

(53) *Elphidium simplex* *

(54) *Elphidium excavatum* *

(55) *Operculina gaimardii* *

(56) *Bolivinella margaritacea* *

(57) *Bulimina marginata* ** *** *** ** * *

(58) *Virgulina squamosa* * * * **
### Table II (Contd.)

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</table>

#### Benthic Species

- **Virgulina concava**
- **Virgulina pauciloculata**
- **Bolivina nobilis**
- **Bolivina vadescens**
- **Bolivina hantkeniana**
- **Bolivina capitata**
- **Bolivina striatula**
- **Loxostoma limbatum**
- **Loxostoma rostrum**
- **Uvigerina ampullacea**
- **Uvigerina proboscidea**
- **Discorbis globularis**
- **Discorbis rosacea**
- **Discorbis vilardeboana**
- **Discorbis auracana**
- **Discorbis bertheloti**
- **Lamarckina ventricosa**
- **Eponides repandus**
- **Streblus beccarii**
  - (Linnaeus) va koeboeoenis
- **Cancris auricula**
- **Calcarina calcar**
- **Plamulina ornata**
- **Anomalinella rostrata**
- **Cibicides lobatulus**
- **Cibicides pseudo-ungeriana**
- **Globigerina bulloides**

#### Planktonic Species

- **Globigerina bulloides**
Some Foraminifera from Northeastern Part of the Arabian Sea

TABLE II (Contd.)

<table>
<thead>
<tr>
<th>Station Number</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
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<tr>
<td>Depth in Meters</td>
<td>64</td>
<td>64</td>
<td>77</td>
<td>37</td>
<td>27</td>
<td>14</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Planktonic Species</td>
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<tr>
<td>(85) Globigerina calida</td>
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</tr>
<tr>
<td>(86) Globigerinella aequilateralis</td>
<td>**</td>
<td>*</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
| (87) Globigerinoides ruber | ** | ** | *** | | | | | *
| (88) Globigerinoides sacculifer | | | | | | | | *
| (89) Orbulina universa | * | | | | | | | *
| (90) Globorotalia menardii | | | | | | | | *
| (91) Globorotalia tumida | * | | | | | | | |
| (92) Globoquadrina dutertrei | ** | ** | ** | * | * | | | * |

*** Dominant  ** Subdominant  * Rare

The only representative of planktonic Foraminifera, *Globigerina bulloides* is also met with.

Station 28: The faunal content is almost same as the previous station and families of Foraminifera represented at this station are Rotaliidae, Miliolidae, Buliminidae, Lagenidae and Nonionidae. The most dominant species of rotalids is *Streblus beccarii* (Linnaeus) var. *koebbeenis*. *Discorbis rosacea* is a common species in the sample. Miliolids belonging to genera *Quinqueloculina* and *Triloculina* are frequent. *Quinqueloculina seminulum* and *Triloculina trigonula* are some of the common species of the miliolid group at this station.

Pelagic forms form 14.66% of the total fauna represented at the station.

**GENERAL REMARKS**

Some aspects on the concentration of Foraminifera from the area studied. A total number of 92 species was observed and they were grouped under 40 genera and 16 families, *viz.*, Textulariidae, Valvulinidae, Miliolidae, Ophthal-midiidae, Trochamminidae, Lagenidae, Planorbulinidae, Nonio-
nidae Camerinidae, Heterohelicidae, Buliminidae, Rotaliidae, Calcarinidae, Globigerinidae, Globorotaliidae and Anomalinidae.

Fig. 17. Ammomas$ilina alveoliniformis. Fig. 18. Tubinella funalis var. inornata. Fig. 19. Pyrgo subspherica. (a, dorsal view; b, ventral view.) Fig. 20. Cornuspiroides foliaceus. Fig. 21. Cornuspira involvens. Fig. 22. Lagena laevis. Fig. 23. Lagena graciliformis. Fig. 24. Lagena punctulata. Fig. 25. Lagena perlicida. Fig. 26. Lagena hexagona. Fig. 27. Lagena semistriata.
Some Foraminifera from Northeastern Part of the Arabian Sea

From the study of the relationship between foraminiferal number, i.e., the total number of foraminiferal specimens present in one gram of sediment (dry weight) and depth, it is observed that a definite relationship exists. With the increase of depth, the number of Foraminifera increases (Fig. 4). In general, specimens of Foraminifera observed at the collecting stations are in a good state of preservation as they must have been buried in the sediments without being exposed on the surface of the seafloor.

A detailed study of the foraminiferal fauna at species level has revealed that some forms are dominant, others subdominant and still others rare. On the above-said classification the order of frequencies is given in Table II.

Foraminiferal species recorded for the first time in Indian waters are (1) Textularia pseudocarinata Cushman, (2) Virgulina concava Högland, (3) V. pauciloculata H. B. Brady, (4) Loxostoma rostrum Cushman, (5) Lagena sulcata (Walker and Jacob) var. spicata Cushman and McCulloch, (6) Lagena costata (Williamson) var. amphora Reuss, (7) Elphidium oceanicum Cushman, (8) Discorbis auracana Cushman and (9) Globigerina calida Parker.

The foraminiferal fauna of the continental shelf waters of the study area is almost identical with that of Gulf of Cambay (Rao, 1970). Most of the species observed from the northeastern part of the Arabian Sea have also been recorded from the tropical Pacific and Philippines.

The benthic Foraminifera.—These are bottom dwelling forms on the surface of the sea floor. Arenaceous Foraminifera belonging to the families Textulariidae and Trochamminidae have been reported from Stations 21 and 22 and are entirely lacking in other stations. These forms are somewhat common in regions where the type of bottom sediments is an admixture of sand and mud. Besides the above-said families, the benthic Foraminifera are represented by Valvulinidae, Lagenidae, Planorbulinidae, Nonionidae, Camerinidae, Heterohelicidae, Buliminidae, Rotaliidae, Calcarinidae and Anomaliniidae.

Relatively high percentages of perforate benthic and planktonic Foraminifera have been observed at Stations 24 and 25 (Fig. 7).

Imperforate Foraminifera belonging to the families Miliolidae and Ophthalmidiidae have been reported and very high percentages of these Foraminifera are found at Stations 27 and 28 (Fig. 6) where depth is below 20 meters. It is evident that heavy concentration of these forms is due to their preference for shallow nearshore regions where water is usually warm.
Figs. 28–38. Fig. 28. *Lagena sulcata* (Walker and Jacob) var. *spicata*. Fig. 29. *Lagena* (Williamson) var. *amphora*. Fig. 30. *Lagena marginato-perforata*. Fig. 31. *Lagena lagenoides*. Fig. 32. *Robulus limbosus*. Fig. 33. *Planorbutilinella larvata*. Fig. 34. *Nonion scapha*. Fig. 35. *Elphidium advena*. Fig. 36. *Elphidium striato-punctatum*. Fig. 37. *Elphidium oceanicum*. Fig. 38. *Elphidium simplex*.

The Planktonic Foraminifera.—These are pelagic forms preferring exclusively open sea habitat and they are represented by two families, viz., Globi-
Figs. 39-48. Fig. 39. *Elphidium excavatum*. Fig. 40. *Bolivinella margaritacea*. Fig. 41. *Virgulina concava*. Fig. 42. *Virgulina pauciloculata*. Fig. 43. *Bolivina hantkeniana*. Fig. 44. *Bolivina capitata*. Fig. 45. *Bolivina striatula*. Fig. 46. *Loxostoma rostrum*. Fig. 47. *Uvigerina ampullacea*. Fig. 48. *Uvigerina proboscidea*.

gerinidae and Globorotaliidae. Planktonic species which are common in this region are *Globigerina bulloides*. *Globigerinoides ruber*, *Orbulina universa*,
Figs. 49–59. Fig. 49. Discorbis auracana. Fig. 50. Lamarckina ventricosa. Fig. 51. Eponides repandus. Fig. 52. Cancris auricula. Fig. 53. Globigerina calida. Fig. 54. Globigerinoides ruber. Fig. 55. Globigerinoides sacculifer. Fig. 56. Orbulina universa. Fig. 57. Globorotalia tumida. Fig. 58. Planulina ornata. Fig. 59. Anomalina rostrata. (a, dorsal view; b, ventral view.)
Some Foraminifera from Northeastern Part of the Arabian Sea

Globoquadrina dutertrei and Globorotalia menardii. Globigerina calida, Globigerinoides sacculifer and Globorotalia tumida are rare.

Further observations have shown that forms belonging to the genus Globigerina are bigger and mature in deeper waters and those found in the shallower depths are smaller and immature types. Percentages of planktonic Foraminifera at the stations covered range between 5.33% and 30.66% (Fig. 5). Relatively large percentages of planktonic Foraminifera have been observed near the mouth of Gulf of Cambay and Gulf of Kutch. In general, percentage of planktonic Foraminifera increases with depth.

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